ESM 410/510 – Snow Hydrology – Winter 2024

Where: In-person on-campus at Lincoln Hall 301
When: T & R: 2:00-3:50 pm
Instructor: Kelly E. Gleason (SRTC B1-04D, Phone: 5-2334, email: k.gleason@pdx.edu)
Gleason office hour: Wednesday 3-4:00 pm or by arrangement
Teaching assistant: Monica Zapata (email: mzapata2@pdx.edu)
Zapata office hour: Wednesday 11-12:00pm or by arrangement in SRTC 166
Text: DeWalle, David R. and A. Rango, 2008. Principles of Snow Hydrology
Need: Calculator, paper, and pencil. Excel, word, and powerpoint software access.
Zoom Class: Live Zoom Lectures will be available during class period for those that have excused absences or COVID symptoms here, https://pdx.zoom.us/j/83244181566

This syllabus is tentative and subject to change throughout the course as necessary to support your learning objectives.

Portland State University Land Acknowledgement:

Portland State University is located near the heart of downtown Portland, Oregon in Multnomah County. We honor the Indigenous people whose traditional and ancestral homelands we stand on, the Multnomah, Kathlamet, Clackamas, Tumwater, Watlala bands of the Chinook, the Tualatin Kalapuya and many other Indigenous nations of the Columbia River. In remembering these communities, we honor their legacy, their lives, and their descendants. It is important to acknowledge the ancestors of this place and to recognize that we are here because of the sacrifices forced upon them.

Course Description

Snow is a key component in the hydrologic cycle of our planet. Approximately half of the North Hemisphere land surface is covered by snow during the winter. Mid-latitude mountain regions receive most of their annual precipitation in the form of snow. Snowmelt provides water for irrigation, hydropower, and ecosystems and it is also important for winter recreation. This course provides a comprehensive introduction to the principles and techniques of snow hydrology. This course will focus on the fundamentals of snow hydrology. Topics covered will include:

- History of snow hydrology
- Processes of snow formation, snowpack accumulation, and redistribution
- Snowpack energy balance and snow metamorphism
- Processes of snowpack ablation
- Snow cover-climate interactions
- Remote sensing of snow
- Avalanches
- Methods for measuring and modeling snow

Note: There will be algebraic math required in the workshop assignments for this course.

In-Person and Zoom: This is an in-person class on-campus, and is meant to provide in-person feedback and learning in a live classroom environment. Although there will be live Zoom lectures and regular recordings to assist should you need to be absent from class, this is not a hybrid or virtual class, but meant to be delivered in person. If the Zoom link is not working for any reason, the in-person class will be prioritized, so please plan accordingly.

Canvas: We will use ***Canvas*** to manage this course, an on-line learning system (https://canvas.pdx.edu). You need to use your ODIN user name and password to log in. Class materials such as syllabus, homework assignments, lecture PowerPoint presentations, grades, and extra readings will be posted in "Canvas". Students are encouraged to use "Canvas" to post questions, comments, and suggestions. **Canvas' email system works in a mysterious way and I strongly recommend that you don't use Canvas to email me.**

Required Readings

DeWalle, David R. and A. Rango, 2008. Principles of Snow Hydrology, Cambridge University Press, Cambridge, UK, 410 pp.

Recommended Readings

Sturm, Matthew. A Field Guide to Snow. University of Alaska Press, 2020.

Course Learning Objectives

All Students completing ESM 455 Snow Hydrology should be able to:

1) Explain processes of snow formation in the atmosphere, snow-climate interactions, and physical mechanisms in the snowpack accumulation, redistribution, and ablation;
2) Explain processes relating to the internal energetics of snow;
3) Summarize methods for mapping snow and modeling snowmelt;
4) Perform field analyses of snowpacks;
5) Synthesize the above objectives in understanding the role of snow in watershed processes.

Additionally, graduate students completing ESM 555 Snow Hydrology should be able to:

1) Design a sampling scheme for snow measurements in the field;
2) Formulate a research hypothesis related to snow hydrology;
3) Design and perform a snow hydrology research project;
4) Analyze the data and draw a conclusion with respect to the hypothesis;
5) Communicate the research in a professional and effective manner.

The extra credit field trip will allow students to become familiar with field techniques for snowpack measurements and sampling equipment.

Field Trip

An extra credit snow hydrology field trip will provide a hands-on opportunity for students become familiar with field techniques in snowpack measurements and sampling equipment. Data collected from the field trip will be utilized in homework assignment #7. The dates for the all-

day field trip will be determined depending on the availability and weather. Field equipment will be provided. Tentatively we are planning for the Week 6 or 7 on Friday or Saturday. Vans will be provided for transportation to and from the field trip location.

Undergraduate Student Grade Weighting:

7 weekly exercises (starting in Week 2)	40%
Midterm exam	40%
Quizzes	10%
Participation	10%

Graduate Student Grade Weighting:

7 weekly exercises (starting in Week 2)	40%
Midterm exam	20%
Term project	30%
Quizzes	5%
Participation	5%

Grade Scale Grades are based on the percentage of maximum points accumulated and assigned according to the following table:

A > 92%	B+ 89%	C+ 76%	D+ 66%	F < 60%
A- 90-92%	B 85%	C 73%	D 63%	
	B- 80%	C- 70%	D- 60%	

Homework Assignments
There will be 7 weekly homework assignments. Each Thursday a new assignment will be handed out and it will be due no later than the beginning of class on the following Thursday.

1. Problem sets on snowfall
2. Problem sets on snow processes
3. Literature review
4. Problem sets on energy balance calculations
5. Problem sets on snowmelt
6. Problem sets on snowmelt contributions to streamflow
7. Snow hydrology scenarios

Graduate Students have extra problem sets included in all homework assignments.

Literature review for assignment 3 but presentations on Tuesdays throughout quarter
Suggested topics for the literature review in snow hydrology include:
•Snow hydrology in a changing climate

•Snowmelt modelling
•Snowmelt flooding, rain-on-snow floods
•Snowmelt and groundwater recharge
•New measurement techniques in snow hydrology (sensors, isotopes, etc.)
•Remote sensing of snow
•Snowpack sublimation Melt water movement in snow
•Effects of vegetation and land cover change on snow
•Snowpack energy balance in different climate regimes
•Snow redistribution mechanisms
•Snow and water resources management (irrigation, hydropower, flood control)

Each student will present a 3-minute presentation to the class of one peer reviewed scientific paper related to Snow Hydrology and used toward your literature review to the class every Tuesday starting in Week 2.

Reading Assignments
Reading assignments are required each week. Students must complete these assignments before attending the corresponding lecture. Please see the weekly schedule for the list of reading assignments. Graduate students should supplement the readings in the textbook with journal articles (see the list at the end of the syllabus for suggestions).

Graduate Student Projects
Graduate students have an additional requirement to complete a project on a subject involving snow hydrology. Graduate students will work in teams of two persons to develop the topic, hypothesis, methodology, and analysis. Each team will develop a presentation to be given in class. However, the final write-up must be an individual effort. The subject of the project should be discussed with the instructor within the first two weeks of the course. The project will be graded in two parts. For the first part, each student will need to provide me with a 2-page write up that includes your hypothesis or problem statement, a description of the study site, description of the snow hydrology data set(s), and an example of the data (showing me that you have downloaded the data and have worked with it). This is due on Friday, January 19th by 5PM. This will be assessed as 0 (not satisfactory), 1 (good but you need to reconsider some aspects of the project), 2 (great- you are on track) but is not assigned a point value.

The final portion of the project will be a 4-page paper and an in-class presentation made by your team. The presentation is made by your team and the 4-page paper is an individual effort. Your full grade on the project is determined by your 4-page paper and your team presentation. In your paper and presentation, you will need to provide an overview of the project (problem statement or hypothesis, significance and motivation, specific objectives, methodology, data sources, study area including a map), analysis of the results, discussion of their meaning, careful and clear presentation of figures, and discussion of sources, magnitudes, and implications of errors. Presentation of the graduate student term projects will take place on March 12th and March 14th, and the 4-page papers are due on March 21th.

The 4-page papers are to be written as a journal article in the style of Geophysical Research Letters (GRL; https://agupubs.onlinelibrary.wiley.com/journal/19448007).
Please read the AGU Author Guide and follow the format for GRL.

Attendance
Students are expected to attend all lectures except with an excused absence. It is expected that students will arrive on time. Participation points will be primarily weighted by class attendance.

Special notes
If you have a conflict between religious observances and class lectures or field trips, please let me know in advance so these can be made up.

Students with documented disabilities who may need accommodations, who have any emergency information the instructor should be aware of, or who need special arrangements in the event of an evacuation, should make an appointment with the instructor as early as possible, and no later than the first week of the term. Class materials will be made available in an accessible format upon request.

All students should review the PSU policies on classroom conduct and academic honesty at, https://pdx.smartcatalogiq.com/en/2016-2017/Bulletin/Student-Policies-and-Guidelines/Student-Conduct

Weekly Schedule (Lectures are Subject to Change):

Week	Topics	Required Readings	Assignments Due Thursday evening
1	Introduction; History of snow hydrology; Snow formation in the atmosphere; Snow accumulation, interception, and redistribution	Chapters 1 & 2	
2	NO CLASSES – WINTER WEATHER		
3	Dry snow metamorphism; Wet snow metamorphism; Head conduction in snow; Snowpack temperature and cold content; Liquid water in snow	Chapter 3	HW1
4	Ground-based snowfall and snowpack measurements	Chapter 4	HW2
5	Remote sensing of snow	Chapter 5	HW3
6	Snowpack energy exchange;	Chapters 6 & 7	HW4

	Topographic and forest effects on energy balance		
7	Snowmelt runoff processes; Water balance, meltwater flowpaths; Frozen ground Field trip Saturday February 24th	Chapter 9	HW5
8	Snowpack and snowmelt chemistry; Snowpack stable isotopes MIDTERM on February 29th	Chapter 8	HW6
9	Modeling snowmelt runoff	Chapters 10 & 11	Graduate students submit draft paper for peer review
10	Climate change and snow: implications for water resources; Snow management: urban issues, forest management	Chapter 12	
10	**Graduate student project presentations**		Peer review grad projects - due by March 12th

Grading notes:

- Labs may be competed in groups, but each write-up must be done individually.
- Early or late exams or quizzes will not be offered.
- **Late homework/lab assignments: -10% for each class day late, and up to one week late or -50% maximum.**
- Homework/lab assignments should be typed as much as possible but calculations may be handwritten. Essays should be typed.

Note: Borderline grades (e.g.: 89.9) will be determined at the discretion of the instructor based on individual effort and class attendance.

Roles and Responsibilities: Students and Faculty

My expectations of each student are high. I ask you to:

1) ***Take responsibility for your own learning in this course*** It is YOUR learning.
2) Conduct yourself in a courteous and collaborative manner
3) Attend every class and lab on time
4) Be prepared each day
5) Think critically and ask questions
6) Be engaged in the course material and put *work* into your learning
7) Avoid use of internet-enabled devices during class (unless instructed to use)
8) Exhibit academic integrity

You can do this by reading assignments before lectures, integrating new concepts and terminology as the semester progresses, always keeping the big picture in mind, and recognizing

that the details are vital to understanding. Be an active participant both verbally and intellectually.

For our part, we aim to keep grading clear and fair. Given the volume of email we receive, we cannot always respond promptly and concisely to each email -- it is best to talk to us after class, in lab, if office hours, or by appointment.

We will aim to keep lectures clear, learning objectives transparent, and be well-organized throughout the semester. We will return weekly labs and quizzes as soon as possible. The clearer and cleaner and correct your assignments are when you turn them in, the faster we will be able to grade them and return them to you! In sum, we aim to create a challenging but rewarding and fun class atmosphere to help you learn and grow conceptually and quantitatively.

Snow and Hydrology Links

Check out the following www sites for information and data relevant to hydrology:

NASA – Snow Science: https://snow.nasa.gov/

NRCS – Snotel Interactive Map: https://www.nrcs.usda.gov/resources/data-and-reports/snow-and-water-interactive-map

USGS Water Center: http://www.usgs.gov/water/

National Hydrographic Dataset: http://nhd.usgs.gov/

National Weather Service: http://www.weather.gov/

Natural Resource Conservation Service Hydrology & Hydraulics:

http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/water/manage/hydrology/

HJ Andrews Experimental Forest: http://www.fs.fed.us/pnw/exforests/hjandrews/

COVID POLICIES

Classroom Requirements for All Students and Faculty Due to Covid-19

The University has established rules and policies to make the return to the classroom as safe as possible. It is required for everyone to follow all the Return to Campus rules and policies. To participate in this class, PSU requires all students to comply with the following.

COVID-19 VACCINE REQUIREMENT

Portland State University's COVID-19 Vaccine Policy requires all students who learn, work, and engage at PSU locations to submit either (1) an attestation confirming the student is fully vaccinated; (2) an attestation confirming they will not be taking in person classes, living in on-campus housing and not be using in person services; or (3) submit an applicable exemption as described below.

This requirement applies to all students enrolled in or registered for in-person instruction for any portion of their course load. It also applies to students who are registered for fully online courses and participate in any on-site or in-person university activity or university-provided or sponsored service.

Health Check, Illness, Exposure, or Positive Test for COVID-19

Complete the required self-check for COVID-19 symptoms before coming to campus each day.

Please do not come to class if you are feeling ill or showing any symptoms of COVID-19.

Please notify me (i.e. your instructor), should you need to miss a class period for any of these reasons so that we can discuss strategies to support your learning during this time.

Failure to Comply with Any of these Rules

As the instructor of this course, the University has given me the authority to require your compliance with these policies. If you do not comply with these requirements, I may ask you to leave the classroom, or I may need to cancel the class session entirely.

In addition, failure to comply with these requirements may result in a referral to the Office of the Dean of Student Life to consider charges under PSU's Code of Conduct. A student found to have violated a university rule (or rules) through the due process of student conduct might face disciplinary and educational sanctions (or consequences). For a complete list of sanctions, see Section 14 of the Student Code of Conduct & Responsibility.

Guidance May Change

Please note that the University rules, policies, and guidance may change at any time at the direction of the CDC, State, or County requirements. Please review the University's main COVID-19 Response webpage and look for emails from the University on these topics.

Email: Please allow 48 hrs for me to respond via email. When emailing me about anything, please make clear subject lines including your name, the class, and the reason for your email, and I will respond as soon as reasonable.

Cheating or plagiarism in any form is unacceptable. Cheating includes, but is not limited to: copying work or allowing your work to be copied; use of unauthorized material during quizzes and exams; any communication between students during quizzes and exams, including take-home exams; actively looking at another student's paper during a quiz or exam. Plagiarism includes copying from or resubmitting homework from a previous semester, whether your own work or that of another, whether previously graded or not. Plagiarism also includes using laboratory data from another person [unless specifically instructed to share data] or from a previous semester. Any occurrence of cheating may be reported to the Office of Student Conduct. Reports of cheating, or suspected cheating, by classmates will be kept strictly confidential and anonymous to every extent possible. Cheating by classmates inflates grades and dilutes the value of ethical hard work. Cheating may incur various consequences, up to and including course failure.

Safety is a top priority in the classroom, lab, and field. Safety protocols will be presented and reviewed as necessary. Safety includes treating each other with respect.

Title IX and Mandatory Reporting Statement:

Portland State is committed to providing an environment free of all forms of prohibited discrimination and sexual harassment (sexual assault, domestic and dating violence, gender or sex-based harassment and stalking). If you have experienced any form of gender or sex-based discrimination or sexual harassment, know that help and support are available. PSU has staff members trained to support survivors in navigating campus life, accessing health and counseling services, providing academic and on-housing accommodations, helping with legal protective orders, and more. Information about PSU's support services on campus, including confidential services and reporting options, can be found on PSU's Sexual Misconduct Response website or you may call a Confidential Advocate at 503-894-7982 or by scheduling on-line: psuwrc.youcanbook.me. You may also report any incident of discrimination or discriminatory harassment, including sexual harassment, to the Title IX Coordinator, Office of Equity and Compliance, or the Office of the Dean of Student Life. Please be aware that all PSU faculty members and instructors are required to report information of an incident that may constitute prohibited discrimination, including sexual harassment and sexual violence. This means that if you tell me about a situation of sexual harassment or sexual violence that may have violated university policy or student code of conduct, I have to share the information with the University's Title IX Coordinator or the Office of the Dean of Student Life. Please complete the required student module Understanding Sexual Misconduct and Resources in your D2L, which provides information about PSU policy and resources.

Mandatory reporting notice: The instructor of this course is required to report any instance or suspicion of harassment or discrimination or intimidation, sexual or otherwise, observed first-hand or brought to the instructor's attention by a student. Please feel free, encouraged, and supported to report instances of harassment or discrimination or intimidation to the instructor. Confidentiality will be maintained to the degree possible while following university, state, and federal policies regarding reported behaviors or incidents.

Emergency Notification System: PSU has made an emergency notification system available for faculty, students, and staff, please register at https://www.pdx.edu/emergency-management/psu-alert-emergency-notification-system. Please register in Banweb with emergency contact information (cell, email, text, etc.). You may have been prompted to complete emergency contact information when registering for classes in Banweb. In the event of a building evacuation, a map at each classroom entrance shows the evacuation point for each building. Please refer to it. Individual class cancellations may be made at the discretion of the instructor.

General student information:

Students with documented disabilities who may need accommodations, who have any emergency information the instructor should be aware of, or who need special arrangements in the event of an evacuation, should make an appointment with the instructor as early as possible, and no later

than the first week of the term. Class materials will be made available in an accessible format upon request.

All students should review the PSU policies on classroom conduct and academic honesty at, https://pdx.smartcatalogiq.com/en/2016-2017/Bulletin/Student-Policies-and-Guidelines/Student-Conduct

All Students

Don't forget to check out the ESM department and School of Environment webpages: http://www.pdx.edu/esm/

http://www.pdx.edu/environment/

Advising & Career Services: https://www.pdx.edu/careers/ and

https://www.pdx.edu/careers/what-can-i-do-degree-environmental-studiesenvironmental-sciences

Library Research Tutorials: http://guides.library.pdx.edu/home/howto and http://guides.library.pdx.edu/biology

Safe Campus: If you have not done so already, please complete the Safe Campus Module in D2L. The module should take approximately 30 to 40 minutes to complete and contains important information and resources. If you are uncomfortable completing the module, please send an email to saveact@pdx.edu to request an exemption. If you or someone you know has been harassed or assaulted, you can find the appropriate resources at Sexual Misconduct Prevention & Response: www.pdx.edu/sexual-assault/. PSU's Student Code of Conduct makes it clear that violence and harassment based on sex and gender are strictly prohibited and offenses are subject to the full realm of sanctions, up to and including suspension and expulsion. http://www.pdx.edu/sexual-assault/safe-campus-module

Learning Center/Free Tutoring: http://www.pdx.edu/tutoring/ PSU library rm 245

Writing Center: for class assignments, resumes... http://www.writingcenter.pdx.edu/ Cramer rm 188

Please consult the Purdue OWL regarding ***plagiarism*** and other writing issues: https://owl.english.purdue.edu/owl/resource/589/01/

Math: https://www.pdx.edu/math/math-resource-lab; Department of Mathematics and Statistics provides free tutors for lower division algebra, calculus and statistics: https://www.pdx.edu/math/resources

Disability Resource Center: If you are a student with a documented disability and are registered with the Disability Resource Center, please contact me so that we can arrange whatever academic accommodations you need.

Veterans: If you are a Veteran and have questions about University services or need assistance with your transition from military to campus life, please contact Chris Goodrich, Coordinator of Veterans Services at the Office of Veterans' Services, SMSU room 425.

Multicultural Centers: https://www.pdx.edu/dmss/multicultural-student-center ; https://www.pdx.edu/dmss/native-american-student-community-center ; https://www.pdx.edu/dmss/la-casa-latina-student-center

Queer Resource Center: www.pdx.edu/queer

Undergraduate Students

See the ESM www site for scholarship opportunities.

LSAMP (Louise Stokes Alliance for Minority Participation) is dedicated to enhancing the undergraduate experience for underrepresented students in Science, Technology, Engineering, and Mathematics. Funded by the National Science Foundation, our LSAMP program focuses on: Creating a community among LSAMP scholars that values excellence, diversity, and persistence; and Expanding opportunities for LSAMP scholars through participation in undergraduate research experiences and leadership initiatives. If you're interested in finding out more, visit our LSAMP center in 103 Epler Hall, talk to ESM-LSAMP faculty advisory member Cat de Rivera <derivera@pdx.edu>, SRTC 238e, or check out: http://www.pdx.edu/lsamp/home

McNair Fellows program - for first-generation to college students as well as students from backgrounds underrepresented in the sciences.

EXITO - first year students interested in health-related disciplines (broadly defined) are encouraged to apply to the NIH-funded EXITO program spring of their freshman year: http://www.pdx.edu/undergraduate-pathways-to-research-careers/about-build-exito